INTRODUCTORY COURSES IN BOTANY. V.

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(Continued from April, 1920.)

OUTLINE No. 17.

A year's high school course, five to seven hours a week.

First half-year.

1. Study of a complete seed plant, including flower and fruit, for a comprehension of the plant as a unit composed of cooperating parts.
2. Leaf structure and leaf types. Uses of leaves determined by experiment. Edible leaves.
3. Flowers. Study of types from simple to complex. Pollination and fertilization.
4. Study of several autumn blooming plants for family characteristics.
5. Structure of monocotyl and dicotyl stems. Distribution of foods manufactured in the leaves. Economic uses of stems.
6. Roots. Garden plants to illustrate root form and food storage.
7. Fruits. Collection from the field and market to illustrate types of fruits and methods of seed dispersal.
8. Weeds. Kinds that seed in the autumn.
9. Bulbs and bulb planting.
10. Trees and forestry.
11. Pines. Acquaintance with several genera of conifers.

Second half-year.

12. Brief study of pteridophytes.
13. Brief study of bryophytes.
14. Brief study of thallophytes.
15. Bacteria.
16. Plant diseases.
17. Seeds and seedlings. Selection and improvement of soils.
18. Spring wild flowers. Representatives of families.
19. Study of native and cultivated shrubs to recognize kinds.
20. Practical garden work. Recognition of weeds.

The purpose of the course is to develop a wide-awake interest in growing plants and a general understanding of their vital and economic values. As much work should be carried on out of doors as weather and time will permit.

OUTLINE No. 18.

A year's high school course, five times a week.

1. General study of some familiar plant to understand its parts and their functions. This introductory study is accompanied by field trips on which common plants are noted and various material collected for winter study.
2. Bacteria. Structure, physiology, and relation to disease.
3. Yeast. Structure and relation to fermentation.
4. Algae. Structure of *Pleurococcus* and *Spirogyra*. Food manufacture. Development of multicellular plants. Sex.
5. Fungi. Structure and life habits of bread mold. Life history of wheat rust. Mushroom. Saprophytism, parasitism. Economic importance.
6. Lichens. Structure. Symbiosis. Field trip.
7. Bryophytes. General structure of *Marchantia*. Structure and life history of a moss. Alternation of generations.
8. Fern. Life history with a study of the vegetative structure of the sporophyte. A comparison with the life history of the moss.
9. Pine. Study of vegetative structure and cones. Development of the gametophytes and seed. Field trips to distinguish different kind of conifers. Economic importance.
10. Angiosperms. A comparison with gymnosperms based on studies of the bean and corn. Then follows (11 to 15) a somewhat detailed study of angiosperm structure.

11. Roots. Forms and cell structure. Relation to the soil. Functions. Food storage and economic value. Experiments on osmosis and conditions necessary for growth.

12. Stems. Kinds and modification of forms. Cell structure and methods of growth in monocots and dicots. An examination of woods, their economic importance. Grafting and budding.

13. Leaves. Various leaf forms. Cell structure in relation to physiology. Food manufacture, transpiration, respiration. A study of raw materials, conditions and products of photosynthesis. Tests for food products. Food storage and economic importance. Experiments and field trips.

14. Flowers. Several types studied for structure and functions of parts. Pollination.

15. Fruits and seeds. Types and structural adaptations. Dissemination. Foods, determined by tests. Germination of seeds with a study of necessary conditions.

16. Useful plants and their products. Cereals, sugar, oils, fibers, drugs, etc.

17. Weeds. Common forms. Dissemination. Damage. Control.

18. Forestry. Methods and importance of timber conservation.

19. Plant breeding. General principles and methods. Seed selection.

20. Plant diseases. Disease producing fungi. Important diseases and their treatment.

The course traces the development of plants from the simplest to the most complex, but the types are largely chosen with reference to topics, which are assembled about them. In the studies on stems, roots, leaves, etc., where physiology is introduced the teacher performs the experiments for the class. The field trips are regarded as valuable since the pupils thus see plants in their natural environment and collect their own material. Many of the topics studied are important in that they connect the scientific with the practical.

OUTLINE NO. 19.

A year's college course, six hours a week.

1. Protoplasm and the organization of the cell. Physical structure and properties of living protoplasm as seen in such plants as *Vallisneria*, *Elodea*, stamen hairs of *Tradescantia*, *Characeae*, molds, etc. *Demonstrations:* Structural elements in stained cells of young and old tissues.

2. Algae. Border-line organisms (living). Unicellular and multicellular algae; structural characters and life histories of one or more types. Fertilization phenomena as in *Fucus*, which can be handled by the students themselves. *Optional studies:* Collections of algae common in aquaria, reservoirs, ponds, etc., and their classification in an elementary way. *Experiments:* Gas release in algae of the filamentous type. Tests for starch. Parallel studies on photosynthesis using larger aquatics and land plants. Respiration.

3. Fungi. (1) Molds. Water mold, fruit and bread molds; structure, nutrition, zygospore development demonstrated by cultural methods. (2) Yeast. Culture and morphological study, fermentation experiments. (3) Bacteria. Studies in hanging drop of non-pathogens, simple experiments in cultures and soil suspensions. (4) Fungi of the ascus type, rust, mushroom; general studies and demonstrations. General consideration of parasitism, saprophytism, symbiosis.

4. Liverwort and moss. Morphological features, life histories, nutrition. Sphagnum, its morphology, distribution, economic importance.

5. Fern. Life history. Display of fern allies and fossil forms.

6. Flower. Morphology. Pollination, fertilization, reduction divisions. Development of embryo. *Demonstrations:* Various types of flowers, reproductive structures in the gymnosperms, ovule development and fruit formation, germination of pollen. *Optional:* Observation of plant breeder's methods and general consideration of the principles of genetics.

7. Seeds. External and internal morphology of endospermic and non-endospermic types. Tests for storage products: starch, fat, oil, protein. Germination studies, interpretation of parts of seedling in terms of embryo. Tests for digestive products in germinating seeds and seedlings. Extraction of enzymes from leaves and seeds (barley). *Demonstrations*; Fruits and seeds, interpretation of parts, adaptations for dissemination. *Optional*; Garden plot, seed selection, testing, disinfection, planting. Soil studies.

8. Structure of young plant (anatomy and histology). Dissection of macerated tissues to determine various structural units. Freehand sections from seedlings of monocots and dicots of roots, stems and leaves, the interpretation of their tissues and functions. *Experiments*; Diffusion, osmosis, plasmolysis, transpiration, absorption. *Demonstrations*; Wood sections showing differentiation of tissues in their mature form. Forest products. Textile fibers. Comparison of normal and diseased tissues of plants of local and regional importance. *Optional*; A study of the trees with keys adapted to the region. Tree planting, grafting. Ecological studies, represented by cross sections of a woodland area, open country, shore line, pond, lake, etc. Contact with the literature on the subject of forestry and problems related to it obtainable from state and federal bureaus.

9. Bud and twig studies. Content of the winter bud. Tests for storage areas. Observations on the unfolding of buds, growth of twigs, and the addition of new leaves and buds.

10. Key studies. Emphasis on the dominant plant families of the region. General principles of classification. Principles of evolution. Plant distribution. *Demonstrations*; Representatives of the great groups of plants with emphasis on those of economic importance.

The course is designed to give training in the fundamentals of structure essential to the interpretation of function in the living plant. The studies are assembled about the great groups to facilitate the orientation of the student in the plant world and to those portions of it that relate themselves conspicuously to human activities.

OUTLINE No. 20.

A half year's college course required in a premedical curriculum, one lecture, two quizzes, and six hours laboratory work each week.

The lectures mostly treat of principles of plant biology with the subject of organic evolution an outstanding feature. Morphology, life histories, physiology and a simple classification are developed chiefly in the quiz periods, the discussions being based on the laboratory work and text book study. Physiological experiments are introduced as demonstrations.

1. Plant cell. Elodea, for structure and protoplasmic movement plasmolysis, osmosis. Euglena or Chlamydomonas for motile protoplasts.

2. The leaf. A short demonstration and discussion of leaf form. Sections of geranium leaf for chlorenchyma, epidermis and hairs. Epidermis of Boston fern (stripped) for stomata. Stained sections of Andromeda leaf for details of cell organization (slides).

3. Chloroplasts and formation of starch. Fresh sections of stem of Pellionia, later stained with iodine.

4. The stem. Brief discussion and demonstration of stem morphology Transverse and lengthwise sections of corn stem (slides). Cross section. of Ricinus stem, two stages covering formation of cambium cylindres. Cross sections of one and two year old stems of Aristolochia, and four year old stem of linden (slides). Study of quartered oak blocks with brief examination of slides.

5. The root. Seedlings of radish for general morphology of young plant and for root regions and root hairs. Root tip of onion (slides). Cross sections of corn root (slides).

6. Mitosis and cell division in root tip of onion.

7. Foods and food storage. Potato starch. Whole wheat flour (starch and protein). Starch from endosperm of corn seedling in process of conversion, compared with starch in ungerminated kernel. Sections of *Ricinus* endosperm (1) test for starch with iodine, (2) stain with Sudan III in alcohol, (3) sections left a few minutes in absolute alcohol to remove fat (oil) then stained with iodine or eosin for structure of aleurone grain. Test sections of cotyledon of bean or pea for character and relative amounts of food.

8. Bacteria. Forms from cultures decaying peas, infusions, etc. Spore formation from cultures of *Bacillus subtilis*. Observations on flasks of milk, (1) left open at room temperature and in ice box, (2) plugged with cotton, pasturized by heating to 65° C one half hour, kept at room temperature, and in ice box (3) plugged, heated to 98° C one half hour, kept at room temperature, (4) plugged, heated to 120° C fifteen minutes, kept at room temperature. Root tubercles on clover.

9. Yeast. Structure from cultures in very dilute molasses. Experiments on fermentation.

10. Simple algae such as *Gloeocapsa*, *Pleurococcus*, etc.

11. *Spirogyra*. Detailed study to cell structure, plasmolysis. Conjugation.

12. *Vaucheria*. Structure and reproduction.

13. *Fucus*. Structure. Fertilization on the slide. Substitute for *Vaucheria* if material is available

14. *Rhizopus*. Structure and life habits. Zygospore formation from cultures or from slides.

15. *Microsphaera*. Life habits, ascocarps.

16. Corn smut or loose smut of oats (brief study).

17. Wheat rust. Life history with examination of uredospores, teleutospores, and aecidia on barberry (slides).

18. Mushroom. Morphology and life habits. Demonstration of bracket fungi, puff balls, etc.

19. Moss. Thorough study of life history to establish alternation of generations. Discussion of chromosome reduction.

20. *Marchantia*. Brief study, emphasizing the small sporophyte.

21. *Sphagnum*. Brief study and discussion of life habits.

22. Fern. General morphology of sporophyte, structure of sporangium and development of spores (slides). Detailed study of prothallus, motile sperms, fertilization, young sporophytes. Life history thoroughly worked out

23. *Selaginella*. General morphology (briefly). Comes in detail. Life history explained.

24. *Equisetum* and *Lycopodium*. Brief study or demonstration.

25. Pine. General morphology. Staminate and carpellate cones. Slides of gametophytes about thirteen months after pollination. Pine seeds, demonstration of seedlings.

26. Flower. Structure of one or more types.

27. Anther and pollen development. Slides of lily anthers with several stages.

28. Ovary, ovules and embryo sac. Slides of lily ovaries.

29. Embryo and endosperm. Slides of lily.

30. Seeds and seedlings. Morphology and germination, bean, pea, corn.

31. Fruits. Demonstration and discussion.

The endeavor is made to put students promptly at work on concrete matter and make them by quiz and discussion do some reading and thinking. The first part of the course deals with the work of the seed plant, developing fundamental principles of plant physiology based on a study of structure. This is followed by a series of type studies with emphasis on the work and life habits of the fungi, and developing for the green plants the idea of a sequence or evolution of types. Life histories are worked out carefully from the bryophytes on, and there is thorough drill on the essential homologies between seed plants and pteridophytes. An understanding of the flower is reached by way of the pteridophytes.

The laboratory studies are planned to cover sufficiently the ground of a text book and the students by quiz work are held to a careful reading and understanding of the text, digging out for themselves the fundamentals of the subject. The lectures are chiefly upon subjects less satisfactorily treated in the text and the course endeavors to reduce formal lecture work to a minimum, substituting for it quiz and class discussion in sections of not more than twenty five students.

Some optional field trips are arranged for students willing to put in extra time but no attempt is made to attract the attendance of students with little or no interest in the subject since such are frequently disturbing elements in the success of field work.

With this the publication of outlines in the hands of the writer is brought to conclusion. The twenty which have been printed are a selection from more than twice as many received and fairly represent the diversity of conditions for which introductory courses in botany are framed and the radical differences of opinion as to material and methods. With conditions so varied in the schools and colleges it is clear that there can be no standardization of the introductory course. Progress will be made by experimentation and will be hastened with the interchange of experience and suggestion. It is hoped that the publication of these outlines has been of some help in this direction.

HIGHEST MOUNTAINS IN IDAHO.

Hyndman Peak is the only named mountain in Idaho that rises above 12,000 feet. It stands near the Blaine-Custer county line and has a height of 12,078 feet. There are, however, several unnamed peaks near Hyndman Peak whose elevations are greater than 12,000 feet, as shown by the contours on the Hailey topographic map, published by the United States Geological Survey.

PROMISING OIL WELLS IN SOUTH-CENTRAL ARKANSAS.

For the last few years geologists have conceded that oil and gas may be found in commercial quantities in southern Arkansas. The formations there are practically identical with those that yield oil and gas in northern Louisiana and the location of the area with relation to the Ouachita and Sabine uplifts indicates that there is in that area favorable anticlinal structure comparable to the anticlines beneath which the Caddo and Homer pools were formed. Development was retarded, however by lack of detailed mapping which would have shown the relations of the beds of southern Arkansas to those of Louisiana for it seemed possible that a fault, known as the Alabama Landing fault, which had been observed in northeastern Louisiana extended across southern Arkansas, and that the beds north of this fault had dropped down so far that the oil-bearing beds would be below the reach of the drill. Recent developments have shown that this fear is groundless, and there is now ample encouragement for active wildcatting in this region. The beds are of the same age as those that bear oil only a short distance to the south; the structural relations indicate that anticlines and domes should exist; and most important of all, tests have actually discovered good showings of oil and have developed gas in paying volume.